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April 29, 1994

Ms. Donna R. Searcy
Secretary
Federal Communications Commission
1919 M Street, N.W., Room 222
Washington, D.C. 20554

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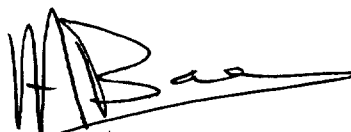
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Dear Ms. Searcy:

On behalf of Cornell University, transmitted herewith are an original and nine (9) copies of its Comments in response to the Notice for Proposed Rule Making to "Establish Rules and Policies Pertaining to a Mobile Satellite Service in the 1610-1626.5 and 2483.5-2500 MHz Frequency Band" - CC Docket No. 92-166.

Should any question arise concerning this issue, please communicate with the undersigned at the Arecibo Observatory.

Very truly yours,



Dr. Willem A. Baan
Spectrum Manager, and
Senior Research Associate

cc: Dr. Daniel Altschuler, Director, Arecibo Observatory
Dr. Donald Campbell, Cornell University
Dr. Michael Davis, Arecibo Observatory
Dr. Tomas Gergely, National Science Foundation
Michael Kimberly, Acting University Council, Cornell

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BEFORE THE
Federal Communications Commission

WASHINGTON, D.C. 20554

In the Matter of)
)
Amendment of the Commission's Rules to)
Establish Rules and Policies Pertaining) CC Docket No. 92-166
to a Mobile Satellite Service in the)
1610-1626.5 and 2483.5-2500 MHz)
Frequency Band)

COMMENTS OF
CORNELL UNIVERSITY
AND THE ARECIBO OBSERVATORY

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MAY 3 1994
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Cornell University ("Cornell"), which operates the Arecibo Observatory (the "Observatory") near Arecibo, Puerto Rico under the terms of a cooperative agreement with the National Science Foundation ("NSF"), hereby submits its comments in response to the Commission's Notice of proposed Rulemaking ("NPRM") released on February 18, 1994, pertaining to the Establishment of a Mobile Satellite Service in the 1610-1626.5 and 2483.5-2500 MHz frequency band.

I. Introduction

Arecibo Observatory, which is part of the National Astronomy and Ionosphere Center ("NAIC") (a federally owned national research facility) is the largest radio/radar telescope in the world. The annual operating budget, supplied by the NSF and supplemented for planetary radar research by NASA, is currently \$9.0 million.

A new Gregorian Upgrade initiative aimed at upgrading the telescope for higher sensitivity and lower system temperature is presently underway and is being funded by the NSF and NASA for \$24 million. The Upgrade program centers on the replacement of one of the two antenna/receiver houses by a Gregorian subreflector system

allowing operation from 300 MHz to 10 GHz. This secondary/tertiary subreflector system will be housed in an 85 ft diameter space frame. The Arecibo Observatory plays a leading role as a versatile research instrument in radiophysics.

The Arecibo Observatory has a mission to provide a highly competitive instrument for use by the astronomy research community in the United States and the world at large. The emphasis for the instrumentation has always been on high sensitivity observations combined with low noise receiver systems. The Gregorian Upgrade will dramatically increase the observing sensitivity and effectiveness of the telescope, which is proportional to the ratio of telescope aperture and system temperature. As a result of this great performance, astronomers have successfully used the Observatory for detection experiments throughout the radio spectrum. The success stories of the Observatory include searches for highly Doppler shifted neutral hydrogen from faraway galaxies, for radio pulsars¹ and planetary systems², and the detection of molecular emission from other galaxies³. The Arecibo Observatory effectively serves the astronomer in his quest to search for the unknown and "To boldly go where no man has gone before".

II. Protection of the 1610.6-1613.8 MHz Frequency Band from MSS Out-of-band emission

The interests of the U.S. radio astronomy community are represented by the Committee on Radio Frequencies ("CORF"), a standing committee of the National Research Council for the National Academy of Sciences. CORF participated actively in the Commission's MSS Above 1 GHz Negotiated Rulemaking Committee

¹The discovery by U.S. astronomers of a compact binary system containing a rapid radio pulsar in 1973 at Arecibo Observatory has been awarded the Nobel Prize for Physics in 1993. This binary system has provided a strong independent confirmation of Einstein's General Theory of Relativity. Furthermore, pulsars are presently being used for long term time keeping, which provides accuracies rivalling those of man made atomic clocks.

²The recent discovery, and continuing observations, at Arecibo Observatory of a rapidly rotating radio pulsar has provided strong evidence of three planet sized objects in orbit around the pulsar.

³The detection of hydroxyl (OH) emission in 1983 at Arecibo Observatory in a prominent galaxy called Arp 220 has been the first of more than fifty detections of such high redshift emission. The emission originates deep within the nucleus of the galaxy and provides valuable insight into the physics of the nuclear region. Emission in the main OH transitions with rest frequencies of 1665 and 1667 MHz has been detected to Doppler shifted frequencies as low as 1318 MHz. Extragalactic OH emission will be further discussed in section III.

("MANRC"). The recommendations of MANRC relating to radio astronomy have been generally incorporated into the present NPRM and Cornell supports those stipulations intended to protect radio astronomy. The protection zones proposed by MANRC and by the present NPRM serve to protect all U.S. radio observatories active in this band. Cornell supports the definitions and comments given by CORF in this matter. Cornell further supports the notion that the Electromagnetic Spectrum Unit at the NSF serve as a clearing house for information about periods during which radio astronomy observations are scheduled.

However, Cornell is concerned over the actual wording of sections in 25.213(a) by which the Commission proposes to implement the MANRC recommendations. The proposed wording of Section 25.213(a)(v) in the NPRM covers the protection of radio astronomy from MSS Mobile Earth Station ("MES") emissions within the 1610.6-1613.8 MHz band. Protection zones have been proposed to facilitate the coordination between MSS operators and radio astronomy during periods when observations are scheduled. However, out-of-band emissions from MES operations inside a protection zone can be as devastating for radio astronomy observations as in-band emissions from MES operations. Cornell urges the Commission to apply the same power flux density ("PFD") standards for out-of-band emissions as for in-band emissions within the radio astronomy band of 1610.6-1613.8 MHz. In particular, the frequency use of MSS systems will increasingly approach the radio astronomy harmful emission levels as the system becomes more successful and more widely used and the threat from out-of-band emissions will only increase with time. The potential for out-of-band emissions going above the harmful PFD thresholds for radio astronomy observations is present for both the groundbased CDMA operations and the groundbased and spaceborne FDMA/TDMA operations. Both types of systems should be subjected to the same PFD limits inside the 1610.6-1613.8 MHz band.

III. Passive Use of the 1610-1667 MHz Band

The co-primary allocation of the Radio Astronomy Service ("RAS") in the 1610.6-1613.8 MHz band is aimed at protection of one of the ground state transitions of the Hydroxyl (OH) molecule. The primary status of the RAS in the 1660-1670 MHz band provides protection for observations of the 1665 and 1667 MHz transitions. These two narrow bands allocated to the RAS allow for observations of

hydroxyl in a great variety of places and under a great variety of physical conditions within our Galaxy and galaxies in the immediate vicinity of our Galaxy.

In analogy with the 1420.4 MHz transition of neutral hydrogen, the hydroxyl molecules can also be detected in other galaxies. Observations at the Arecibo Observatory in 1983 revealed a very strong (in astronomical terms) maser emission line in a galaxy at 222 million light years distance, with a Doppler shifted frequency of 1636 MHz. Since then about fifty such sources have been detected at observatories around the world and many more are to be found with newly equipped telescopes. This unexpected recent discovery provides a unique new research tool. OH maser emission originates in the extreme inner regions of a galactic nucleus and provides the astronomer with an effective probe to study the physical conditions deep inside the nucleus. No other astronomical emissions allow detailed studies on such small size scales. The 1610 to 1667 MHz band has thus been used passively by astronomers to search for redshifted OH emission in galaxies. This type of research is analogous to neutral hydrogen research, which extends into the 1330-1400 MHz band, where footnote US311⁴ protection reminds other operators and administrations "to take all practicable steps to protect spectral line observations of the radio astronomy service".

For these reasons Cornell is saddened by the proposed use of a section in the 1610-1626.5 MHz frequency band for satellite downlink operation. The use of the upper part of the 1610-1626.5 MHz MSS band for MSS downlink systems will have far-reaching consequences for this type of unique research. Up link operations are easier to coordinate than downlinks as there is no terrain shielding to help attenuate the downlink signals.

The NPRM proposes to use the 1621.35-1626.5 MHz for MSS downlink systems, which leaves a 7.55 MHz buffer band between this band and the RAS band of 1610.6-1613.8 MHz. Trusting that the downlink systems will preserve the integrity of the RAS band during observations by staying below the harmful PFD limits for radio astronomy observations, as required by footnote RR733E⁵, this 7.55 MHz band allows for filtering the downlink signals. Assuming that identical filtering will be

⁴Footnote US311 and footnote 718 from the International Frequency Allocation Tables for the 1330-1400 MHz band says: "In making assignments to stations of other services, administrations are urged to take all practicable steps to protect the spectral line observations of the radio astronomy service from harmful interference in the band 1330-1400 MHz. Emissions from space or airborne stations can be particularly serious sources of interference to the radio astronomy service."

applied at the upper edge of the downlink band, this will bring the downlink out-of-band emission levels again below the harmful thresholds at 1634.05 MHz. If these assumptions are correct, the downlink system would effectively produce emission above the harmful limit across 20.25 MHz from 1613.8 to 1634.05 MHz.

The proposed scheme of using downlinks in the MSS band will surely affect astronomical research in a large fraction of the redshifted OH band. Current coordination efforts for the Glonass/Glonass-M system⁶ may help significantly reduce and shift the downlink transmissions of Glonass-M. A downlink in the MSS band can have the same disastrous effects on extragalactic OH research as Glonass had before.


Cornell does not seek protection for astronomical research in the 1613.8-1634.05 MHz band but does wish to explore avenues to preserve access to this unique band for astronomical observations. Cornell and the Observatory want to go on record that the allocation of an MSS downlink in the 1610-1626.5 MHz band can close another valuable window to the Universe. Future expansion of the downlink frequency allocation in order to accommodate the need for spectrum of an undoubtedly successful first generation system could close this window even further.

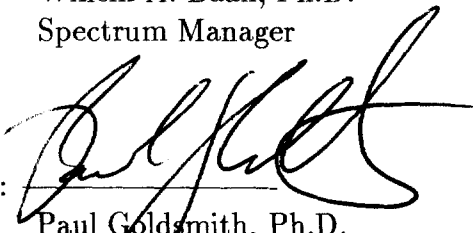
⁵RR733E states "harmful interference shall not be caused to stations of the radio astronomy service using the band 1610.6-1613.8 MHz by stations of the radiodetermination-satellite and mobile-satellite services."

⁶Coordination efforts between the Glonass Administration and the Inter Union Committee on Astronomical Frequencies ("IUCAF") have already resulted in a removal of narrow band Glonass emissions from the 1610.6-1613.8 MHz band. Further coordination efforts are aimed at shifting the transmission frequencies of the broadband Glonass-M emissions and to reduce the occupied bandwidth and by filtering to bring the emission levels below the harmful limits in the 1610.6-1613.8 MHz band. Such efforts will alleviate the effects of Glonass on both Galactic and extragalactic OH research. An agreement has been reached between the Glonass Administration and IUCAF as well as with the Administrations of Australia, Japan, and France. Negotiations with the U.S. Administration are in progress.

Respectfully submitted,

CORNELL UNIVERSITY
and ARECIBO OBSERVATORY

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April 28, 1994